



metroniX
geophysics

Magnetotelluric data acquisition: Quo Vadimus?

Eminar May 3, 2023

Joint Presentation by

Metronix, Zonge International (USA), Phoenix



Summary

- **Joint presentation**

- -Zonge, Metronix, Phoenix agreed to a joint presentation because we share similar experiences and perspectives; but, we agreed : no commercial presentations here; **contact the company websites / sales reps for more info (we're all working on things)**

- **Cost**

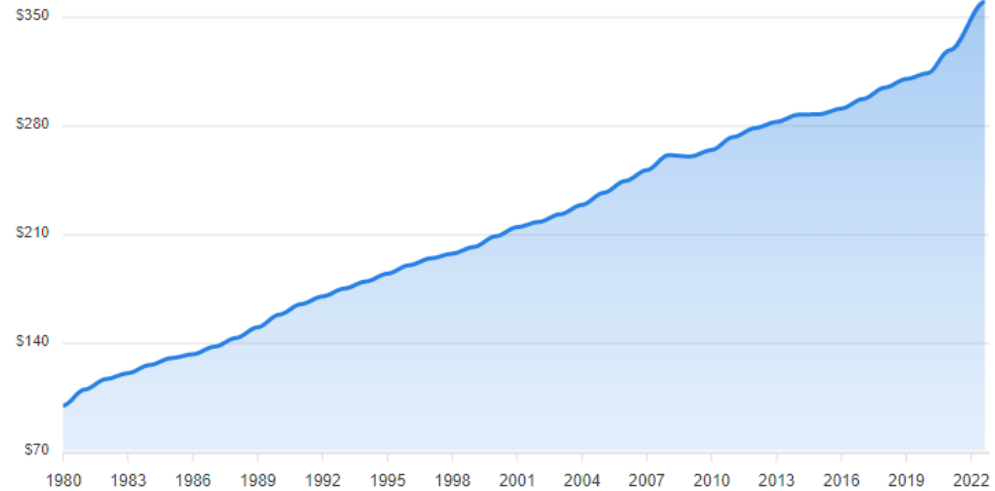
- - it is said that MT equipment is too costly, and that this is the main limiting factor in market expansion; that MT should emulate seismic equipment / evolution / cost per channel

- **Tech and Market trends**

- the seemingly obvious trends don't predict the breakthroughs
- -decrease in MT for hydrocarbon exploration (the main application until recently)

Costs (info from Zonge) – adjust for inflation to compare \$ over time

1 US\$ in 1980 worth \$3.62 in 2022



<https://www.inflationtool.com/us-dollar/1980-to-present-value>

Cost of Instruments over time: ~10x less since 1980

Phoenix example – Metronix and Zonge agree with this

-10 channel MT system in 1980 sold for ca. US\$350K; of which >\$100K was Hewlett Packard equipment (9845 desktop computer, function generator, spectrum analyzer)
=> US\$35K/channel

-5-channel system price in 2023 is ca. \$40K to \$50K => ~\$10K/channel; divide \$10K by 3.62 (previous slide) to get 2023 cost per channel in 1980 dollars => \$2762

-since 1980, the real cost per channel has dropped by a factor of $\$35K / \$2762 = \sim 12.7x$ (call it 10x)

Survey Price over time : ~8.5x less since 1980

Phoenix example; Metronix and Zonge agree

-a 5 component MT site sold for approx. \$3500 in 1980; today, in 2023 est. \$1500.

-multiply by 3.62 to get 1980 cost in 2023 dollars : $\$3500 \times 3.62 = \$12,670$

-so, since 1980, the real cost per site has dropped by approx. 88%

$\$1500/\$12670 = 0.118$; $1 - 0.118 = 0.882$ or 88%; or a factor of $1/0.118 = 8.5$

-at the same time other costs such as fuel, vehicles, helicopters, salaries, accommodation for field crew have greatly increased; these make up most of the cost

-clearly, the decrease is due to increased efficiency enabled by the equipment/SW

Capability increase : explains most of cost decrease

Cost has decreased by a factor of ~10x or more since 1980

At the same time, capabilities have increased : a few (out of many) examples below.

-equipment is much lighter, uses MUCH less power => smaller field crews

-GPS linked remote reference vs cable linked

-bandwidth, memory size, channel count, processing speeds, inversions, etc. have all improved / increased significantly or even dramatically

-just one example (suggested by Zonge): ultra wideband mag sensor halves the sensor count, improves AMT DQ, and can replace a fluxgate

Amortization Cost of Equipment (CAPEX) ~\$50 to \$100/site

Assumptions:

System cost \$40K

Useful Lifespan :10 years (could easily be longer)

Tensor MT Stations per Year : 40 (could easily be more)

Total lifetime stations 400 (could easily be more)

Eqpt. amortization (**CAPEX or Capital Expense**) Per Station: $\sim \$40K / 400 = \sim \100

(the real figure is probably less than this, \$50 is also reasonable)

Amortization : Cost of Equipment vs. other costs

CAPEX: (previous slide) assume est. \$100 / station; ~6% of site acquisition price;

=> if equipment cost \$0, acquisition price might drop by ~6%

OPEX : (Operating expense) – crew **salaries**, hotels, meals, permits, vehicles, **helicopters**, etc. (AUSLAMP LPMT : helicopters ~A\$10K /station) : 80% to 90% of acquisition price

“PROCEX” (Processing Expense) :

– consultants ~\$1500/day (incl. expenses)

-- reprocessing ~\$50 to \$100/site

-- 3D inversions ~\$50 to \$100/site

OPEX and PROCEX can be 2x the data acquisition cost (Zonge)

Hidden Costs (provided by Metronix)

- Development of hard- and software
- Machinery & Tools
- Marketing / Sales / Tender process
- Labor Cost; Warranty
- Accruals for the next generation of instruments
- > these costs have to be included proportionately for each system
- system / board re-design in case the supply chain breaks before end of life of the product
- ability of service & maintenance kept on hand

Summary Costs (provided by Metronix)

- The relative costs have dropped down by a factor of ~10 in 40 years
- The operational costs are the dominating factor (~ 90% to ~95% over lifetime)
- Vendors are competing in a free market
- > the customer gets better equipment at a valuable price

- You are free to enter the market ...

Summary Costs

- realistically: properly engineered, maintained and supported MT equipment for the world market can only be provided through a corporate vehicle
- A company MUST incur the overheads related to ongoing R&D, cost of failures, manufacturing facilities, maintaining sufficient inventory, staff (with benefits), proper accounting, cost of selling, training, ongoing technical support, ongoing technical maintenance, warranty, taxes, and (yes) profit...and more.....
- universities could make a specialized system for a lower price because they do not have to include any such overhead; but in any case, their mission precludes many of the activities above.
- No company can or will make MT equipment at a loss

Comparison with Seismic : ideal but not realistic...Why??

- seismic is indicated as an example for MT to follow; very much an “apples and oranges” comparison
- Seismic demand is still several orders of magnitude greater than MT
- major seismic developments (such as Wireless seismic, STRYDE) were subsidized by oil companies (tens of \$Millions)
- there is no such support for MT
- seismic bandwidth is ~2 decades, MT bandwidth ~8 decades
- seismic sensor is usually a simple mass-produced geophone, usually 1-component (~\$100)
- MT usually measures 5 components
- MT E-sensors are fairly simple (electrodes, wires) but mag sensors are much more complex; several \$K.
- In hydrocarbon exploration, seismic is the go-to technique; MT is a niche technique for compelling technical and scientific reasons
- even reducing MT equipment cost to zero would not change the technical basis for use of MT in oil exploration

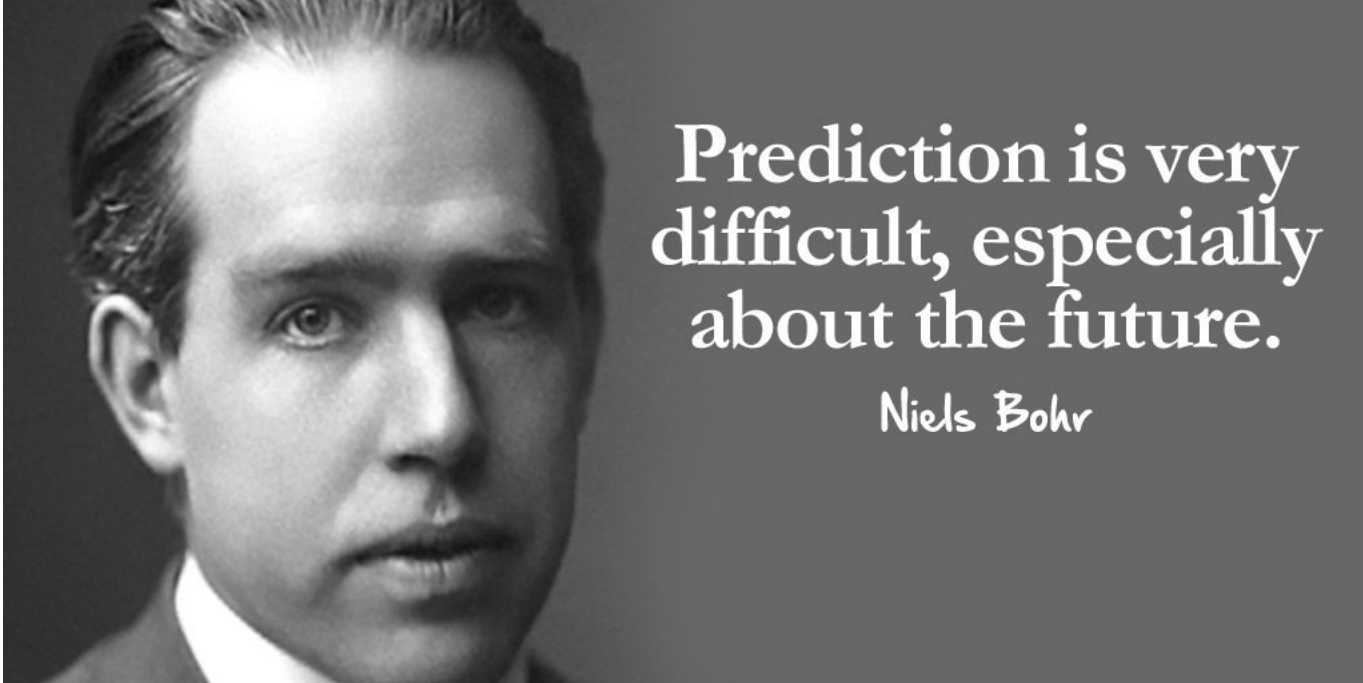
Future equipment trends (~obvious?)

- more memory and more data
- faster processors, more ADC bits
- reduced power consumption
- reduced weight (sensors, batteries)
- more sophisticated processing
- better noise mitigation
- better networking
- remote sensing, permanent observations
- airborne and/or semi-airborne EM

Future market trends (obvious??)

- reduction in MT for hydrocarbon exploration (end of fossil fuels)
- more MT for mining exploration (critical minerals)
- continuous few %/year incremental increase in capability, decrease in cost
- even without breakthroughs, a few %/ yr makes a big difference over a few years

Future equipment trends (non-obvious)



Prediction is very
difficult, especially
about the future.

Niels Bohr

Equipment links

Zonge:

<http://highresreceiver.com>

<https://www.metronix.de/metronixweb/en/geophysics/start/>

www.phoenix-geophysics.com

-QUESTIONS????